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ANALYSIS, SIMULATION AND FABRICATION OF THE REMOTE TERMINAL UNIT FOR AUTOMATED COMMANDO TRAINING SYSTEM

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ABSTRACT

In order to counter the actions of the Anti-Social elements all over the world it is required to have a powerful automated training system which enhances the skills of the security forces to tackle any situation that harms the society. The present system of training includes manual signaling and training of the commandos which is completely wired and utilizes alternate current supply which are the major concerns for the training authorities.

The 'Automated Commando Training System" is a wireless system and utilizes direct current supply. In order to improve the reflexes of the commandos an object lifting mechanism is deployed. The object is a hidden enemy model which is the target and is operated by means of a mechanism which includes Mechanical, Electrical and Electronic systems integrated into one unit called the "Remote Terminal Unit (RTU)". This paper deals with the work of Mechanical Engineering module. The mechanism props up and props down the enemy which is the function of the RTU. The RTU is controlled by a Central Work Station.The module includes analysis of some of the components by using ANSYS software, Simulation by using CATIA V5 R18 software and fabrication of RTU leads to a Product Development.

KEYWORDS: RTU (Remote Terminal Unit), ACTS (Automated Commando Training System), Shaft, Plate with Hubs

INTRODUCTION

The commandos (at least in India) are employed in combing operations in particularly naxalite and terrorist infected areas. They are required to possess very quick reflexes for a surprise enemy presence. These operations are normally undertaken in dense forest areas. Hence the police recruits for these commando operations require undergoing training for improving their reflexes, shooting accuracy, etc. The author of this paper had undertaken a ***consultancy project from National Police Academy (NPA), Ministry of Home Affairs, and Govt. Of India***to design and development of a fully automated training system for this purpose.

The brief operation of this system is as follows. The training location is normally a thick forest with poor visibility with a gross cleared commando walking paths of about 1-2 Kms. Number of pits are prepared with a provision to place a battery operated mechanical system, called Remote Terminal Unit (RTU) to prop-up or prop-down a cardboard made bust image, called model as shown in the Figure 1.

Figure 1: Cardboard Made Bust Image

When propped-up, only the model appears above the ground level and the rest of the mechanism is inside the pit. The commando shall now shoot at the model using the real gun with bullet within the short time duration for which the model is propped-up. The commando does not have prior knowledge of the presence of the RTU.

A Wireless Sensor Network (WSN) consists of spatially distributed devices using sensors to monitor and control physical parameters at different locations. In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver and a microcontroller and it controls the RTU. The objective of this paper is to design and model of the key components in RTU.

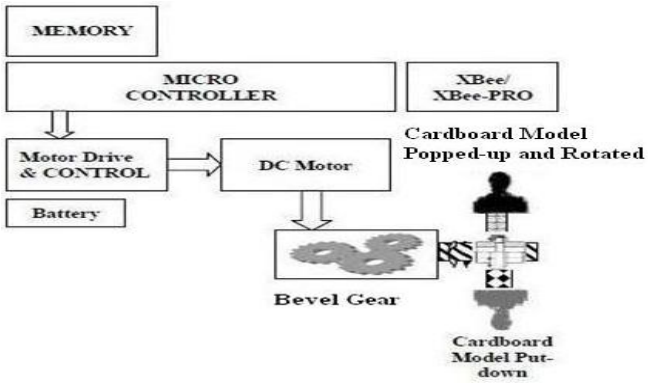

Figure 2: Block Diagram of the Target Hardware

The block diagram of the target hardware implementationis shown in the Figure 2. Designed system employs a micro controller withassociated logics and XBee / Xbee-pro. The micro controllerhardware operates a DC motor. The DC motor is rotated clockwise direction to prop-up the cardboard model and anticlockwisedirection to put it down. The power to the motor isremoved after the model's movement reaches to its designated position.

RFID (Radio Frequency Identification)

Radio-Frequency Identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID Tags or Transponders. The position of the field commandos is monitored by the central station with the aid of a technology called RFID (Radio Frequency Identification) technology. The commandos on the field are provided with RFID tags that help in tracking their position by the central station. The model may rise when a commando comes near the R.T. Unit or in the range of the RFID WAVES. The target is raised when the commando enters into the range of RFID WAVES and is shot with in less than 60 seconds. The target is replaced by a new target after the commando shots the target which is attached to the target rod. The target rod is attached to the shaft of the wiper motor. When the shaft is rotated about an angle (+) or (-) 90˚ the target rod moves up or down respectively. This leads to the motion of the target. The shafts rotation must not exceed (+) 90 or (-) 90˚ because it leads the target to fall down completely.

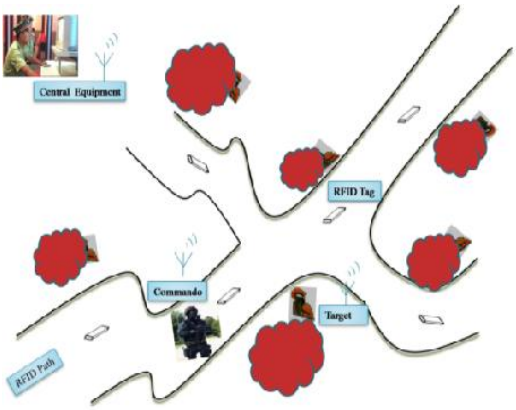

Figure 3: Deployment of Acts System

Need for the project

- **Present System of Training:** The present system of training includes manual signalling and training of the commandos which is completely wired and utilizes Alternate Current (AC) supply which are the major concerns for the training authorities.
- Problems with the present system of commando training :
    - The present training system is highly affected by the climatic conditions and is highly dangerous to the commandos and to the training authorities as it uses 230V AC supply.
    - The present systems highly importable.
    - The present system is high on maintenance and is not highly durable.

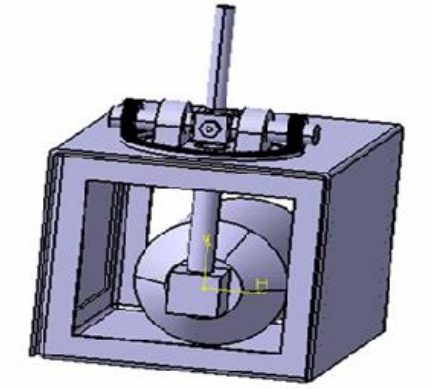

Figure 4: Designed model of the RT Unit

Objectives of the project

- Analysis of the plate with hubs and the shaft by using ANSYS software.
- Simulation of the RTU Unit by CATIA v5 R 18 software
- Fabrication of the RTU Unit which leads to the product development.

Plate with hubs

Figure 5 shows the plate with two hubs which are welded and is connected to, the arm of the motor which has right hand threads to it. There are reverse threads to the plate hole in the middle with a whole thread distance of 5mm.The

plate is connected the shaft through the hubs. The shaft is connected to two gears at the two ends of the shaft. The operation of this plate is to transmit and convert rotation motion into partial up and down motion. Here partial indicates that the target takes an angle of 45˚ of rotation instead of rising with 0˚ angle. The hubs are welded and are very supportive to hold the shaft and have a free rotation without any break downs. These are of 12mm thick and are very useful for maintaining the original displacement and location of the shaft to be inserted and rested.

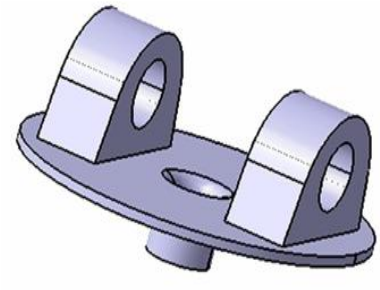

Figure 5: Plate with Hubs

Shaft

Considering the target shape to be a simple rectangle with following dimensions: Length (h) = 0.6 m Breadth (b) = 0.45m. Using the design data book & calculations the diameter of the shaft is finally decided as 20mm. A Shaft is an important element in the design mode. It is a rotating machine element which is used to transmit power. The power delivered to the shaft by some tangential force and the resultant torque set up within the shaft permits the power to be transferred to various linked up to the shaft.

Figure 6: Shaft

EXPERIMENTAL INVESTIGATION OF MECHANISM

Analysis of Plate with Hubs

The plate when rotates undergo various stresses. So when calculated in the software Ansys 10.0 version, it can be seen that the positioning of stresses are clearly visualized as follows.

Table 1: Mesh

Entity	Size
Nodes	2949
Elements	2461

Table 2: Materials

Material	Steel
Young Modulus	2e+011N_m2
Poisson Ratio	0.266
Density	7860kg_m3
Thermal Expansion	1.17e-005_Kdeg
Yield Strength	2.5e+008N_m2

By using the above values for nodal stresses along x, y and z components and von misses stress for the plate are analyzed. It can be seen that the stresses produced in the plate are quite very low. All together in von misses stress as shown it is clearly seen that the maximum stress produce in the plate is 0.327E+13 Nm^2 at a specific point in the plate but most of the plate is undergoing a vey less stress of about 0.364E+12 Nm^2 which means that the plate can resist the stresses produced in it.

Analysis of the shaft

Shaft is used to hold the target and the bevel gear which is inserted through the plate hubs. The maximum stress produced in the shaft is 0.935E+11 Nm^2 at only three specific points inside the shaft which is the extreme case of possibility. Here the shaft is undergoing a stress of 0.160E+09 Nm^2 which is safe and is below the value of the maximum limit.

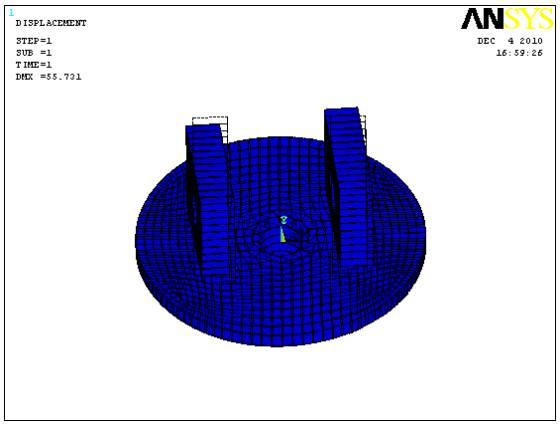

Figure 7: Displacement Deflection in the Plate

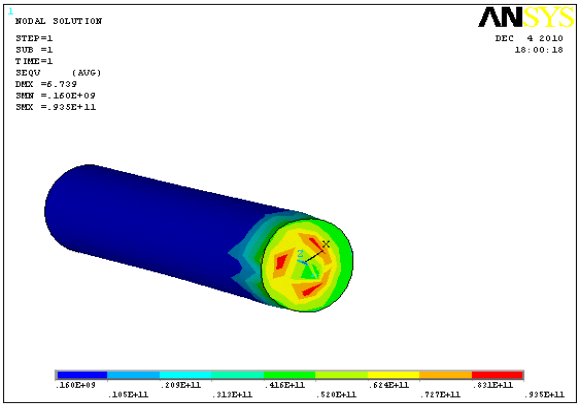

Figure 8: Von Mises Stress of the Shaft

SIMULATION OF THE RTU UNIT

DMU Kinematics Simulator is an independent CAD product dedicated to simulating assembly motions. It addresses the design review environment of digital mock-ups (DMU) and can handle a wide range of products from consumer goods to very large automotive or aerospace projects as well as plants, ships and heavy machinery. DMU Kinematics Simulator is a dedicated DMU Navigator workbench and is available on both UNIX and Windows NT environments.

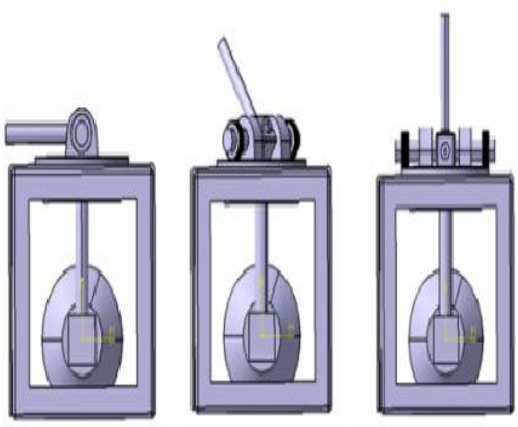

Figure 9: Simulation of the RT Unit

FABRICATION OF THE RTU UNIT

The process of fabrication is the result of this project. It is mostly done by machining and arrangement of all the components. There are about eleven components in this system. They are Casing, Motor, Arm of the motor, Plate with Hubs, Shaft, Target rod, Target, Bevel Gear 1 (Pinion), Bevel Gear 2 (Gear), Battery, Wires.

Connections

These components are connected in the following way from the inside of the casing of the R.T.Unit as the current flows. A battery inside the casing is fixed, passes current to the motor through the electrical components such as relays and electrical wires. Motor converts the electrical energy and into mechanical energy as in the form of arm rotation.

The arm of the motor has threads moves the threaded plate with hubs as that of an operation undergoing with the bolt and nut respectively.

To these plate hubs a shaft which isable to rotate is inserted through them. This shaft has the Target rod and the Bevel Gear 1 fixing. Here the Target rod is connected to the Target. The Bevel Gear Part 1 which is fixed to the shaft such that it should be exactly mounted on the Bevel Gear 2 so that it could rotate on it. The Bevel Gear Part 2 is fixed on the top of the Casing.

Steps followed during fabrication

Step 1: Figure 10 shows the arrangement of motor

Figure 10:Suspended Motor

Step 2: Figure 11 shows the arrangement of gear on the plate

Figure 11: Arrangement of the Gear

Step 3: Figure 12 shows the arrangement of shaft & pinion

Figure 12: Positioning of the Plate

Step 4: Figure 13 shows the stopper welded to the casing

Figure 13: Stopper Attached to the Shaft

Step 5: Figure 14 shows the complete RTU Unit

Figure 14: Target and the RT Unit

CONCLUSIONS

Analysis, Simulation & Fabrication of the RTU Unit is successfully completed, tested and finally led to the product development.

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